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PRIORITISATION OF TARGET AREAS FOR FOREST RESTORATION

Final Report

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Contents

1. Background	1
2. Objectives	1
3. Target audience	1
4. Definitions	2
5. Candidate criteria	2
6. Consultation	6
7. Analysis	6
8. Conclusions	7
9. Recommendations	7
References	8

1. Background

Recent estimates place current global forest cover at 50% of its original extent, with a large proportion of this loss having occurred within the past 50 years. Despite conservation efforts, many of the remaining forest ecosystems have been seriously degraded and fragmented, resulting in environmentally, economically and aesthetically impoverished landscapes.

Loss of forest cover not only limits the scope of biodiversity and genetic conservation but also diminishes the prospect of many rural and coastal populations throughout the developing world attaining a decent and secure livelihood. In many areas, faltering clean water supplies, catastrophic floods and landslides, declining fish stocks and unreliable local weather patterns can be traced back to impaired forest ecosystem functions.

WWF and IUCN are working to develop a co-ordinated programme of work aimed at mobilising public and private sector funds into socially and ecologically appropriate forest restoration initiatives. The programme will aim to provide guidance to governments and industry on good forest restoration practice and on definition of priority areas for such activities.

2. Objectives

The objectives of this study are to:

- identify candidate criteria that can be used for prioritising socially and ecologically appropriate forest restoration at a regional level;
- define broad areas which can provide a focus for a regional restoration programme.

The Mediterranean region was used as a case study. However, the methodology was developed to be applicable, with modification, in any of the other five WWF target areas for restoration (the Lower Mekong, India, East Africa, North West Europe and Central America).

The study does not set out to define actual restoration sites. Such sites requires extensive local knowledge and cannot be identified using coarse (0.1-1.0 km²) resolution imagery.

3. Target audience

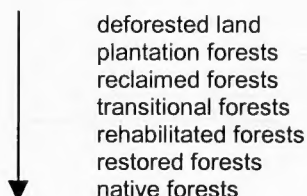
The target audience for this study comprises:

- WWF International and WWF regional offices;
- other organisations requiring a national or regional decision-making tool for prioritising restoration initiatives.

The study is not designed to assist decision-makers working on forest restoration projects at the local level.

4. Definitions

In this study, we use definitions set out in the WWF report: *Global Forest Restoration: a review*. *Reforestation* is defined as the managed reestablishment of forests on lands that once contained forests. Reforestation activities produce different types of forest which may be listed in order of increasing ecological integrity:



Forest restoration therefore involves the establishment of forests containing native species with a high ecological integrity. Restoration is defined as the deliberate alteration of ecological patterns and processes for the purpose of recreating some presumed set of natural, pre-disturbance ecosystem conditions. Restored forests are therefore similar in structure, function and composition to historic forests.

5. Candidate criteria

There are many ecological and social criteria which could be used to identify priority areas for forest restoration. The selection of criteria depends principally on issues concerning the nature of data and is constrained by:

- availability of data (whether restricted by ownership, cost or coverage);
- resolution of data (whether suitable for global, regional, national or local analyses);
- quality of data (whether reliable and/or relevant to the task in hand)
- analysis required (whether or not processing can be carried out within the budgeted time frame).

Twelve candidate criteria were considered on the basis of data held at WCMC. With reference to the constraints set out above, five were selected (see Table 1). Others were considered to have potential, but could not be used given the time constraints of the study. The need to identify global data sets greatly limited the range of criteria for selection.

Selection of criteria must also reflect forest restoration objectives, in particular:

- the desired benefits from forest restoration (whether for biodiversity conservation, recreation, watershed protection and/or production);
- the preferred sites for forest restoration (whether on bare sites, within woodland mosaics, around forest boundaries or within degraded forests).

Objectives were not specified by WWF for the purposes of the study. It was therefore necessary to make certain justifiable assumptions to limit the scope of analysis (see Table 2).

Table 1: Candidate criteria for defining priority areas for forest restoration at a regional level

CRITERIA	Information on data held at WCMC	Decision	Reason for rejection
Original forest areas which are currently unforested	Current forest cover for the Mediterranean region has been derived from CORINE (resolution: 250 m) SEI, ESA and (resolution: 1000 m) landcover maps. Original forest is defined as the post-glacial forest cover which existed around 7000 years ago and is derived from maps of potential vegetation. Original forest cover represents the maximum possible extent of areas which could be reforested.	Accepted	-
Areas containing woodland which are currently unforested	Land use surrounding forest areas has been determined from EROS land cover maps (interpreted satellite images with a 1 km ² resolution) to highlight partially wooded land or woodland mosaics. The 200 classes used on the original land cover maps were reclassified into 3 classes (in descending order of suitability for restoration): <ul style="list-style-type: none"> Grassland and/or arable land with woodland; Grassland and/or arable land and/or shrubland without woodland; Desert, semi-desert, barren land, wetland or urban land. The definition of grassland used here includes pasture and meadow; woodland includes thicket and bushland but not shrubland; arable land includes all land under crops and/or fruit trees.	Accepted	-
Areas of low land use intensity which are currently unforested	Simplified land use maps have been derived from the CORINE land use maps (resolution: 250 m). The 44 classes used on the original land use maps were reclassified into 4 classes (in descending order of suitability for restoration): <ul style="list-style-type: none"> Intensive agriculture Extensive agriculture Natural grasslands, moors, heathlands, burnt areas and sparsely vegetated areas Barren land, glaciers and perpetual snow, marshes, bogs, salines, intertidal flats and water bodies. The definition of intensive agriculture used here includes non-irrigated arable land, permanently irrigated arable land, rice fields, vineyards, fruit trees and bushes, olive groves, annual crops associated with permanent crops, complex cultivation patterns. The definition of extensive agriculture includes pastures, land principally occupied by agriculture with significant areas of natural vegetation and agroforestry areas.	Has potential	The coverage is incomplete (no data for Middle Eastern, North African and some European countries). However, CORINE data could be supplemented with data from EROS to provide global coverage. There was insufficient time available to develop a reclassification methodology which could accommodate both CORINE and EROS data.
Areas of low population density	The population density map has been produced from data for administrative units within countries (Tobler <i>et al.</i> 1995). Gradation was obtained by interpolation between units; the data can be reclassified into any number of density classes.	Accepted	-
Areas on flat or gently sloping ground	A slope angle map could have been derived from the digital elevation model of the world (GTOPO30) with a 1 km resolution.	Has potential	The resolution too coarse (an area of 1km ² in rough terrain may hide steep slopes). However, the data may be helpful if used with information on soil degradation and/or watersheds.

Table 1 (continued): Candidate criteria for defining priority areas for forest restoration at a regional level

Areas in close proximity to existing forests	A map has been generated from the current forest cover map with a buffer width of 1km. The buffer width can be varied (minimum: 250 m for European countries, 1 km for other countries, corresponding to the resolution of forest data sets).	Accepted	-
Areas rich in biodiversity	Centres of plant diversity have been defined by a global WWF project (WWF and IUCN 1994). The global nature of the project means that detail for the Mediterranean region is lacking and the criteria for selection of centres are inconsistent. The areas mapped indicate diversity of plant species in general rather than diversity of forest species (hence the emphasis on montane ecosystems). However, the centres of plant diversity still provide a useful basis for selecting priority areas for forest restoration. To improve the data, WWF European forest hotspots have been added. These hotspots were identified by local forest experts as important centres of forest biodiversity. Such areas may serve as a useful focus for forest restoration. However, less well-known hotspots may have been omitted and forest hotspots have not been identified in non-European countries.	Accepted	-
Important bird areas	Important bird areas have been identified by Birdlife International. Important bird areas are given point locations, but come without associated information.	Rejected	The coverage is incomplete (no data are held by WCMC for North Africa). The data are not helpful without information on associated ecosystems, which could not be generated within the time frame for this study.
Areas around points defined as CORINE biotypes	A CORINE biotype is defined as an 'area of land or a water body which forms an ecological unit of pan-European significance for nature conservation, regardless of whether this area is formally protected by legislation'. The biotypes have point locations, but come without associated information.	Rejected	The coverage is incomplete (there are no data for Middle East, North African and some European countries). The data are not helpful without information on associated ecosystems
Areas already under recognised protection	Global data on protected areas have been collected and mapped by WCMC. Nationally designated protected areas are classified according to IUCN categories (I-VI). Information on internationally designated protected areas is also available.	Has potential	The analysis could not be carried out within the budgeted time frame
Areas not under threat from climate change	Areas most severely affected by climate change have been identified in various climate change and associated vegetation response models with a 1 degree resolution. (Given existing predictions, it would appear that most of the Mediterranean would be unsuitable for forest restoration if this criterion were to be selected).	Has potential	The analysis could not be carried out within the budgeted time frame. The resolution of vegetation models is possibly too coarse to be applied sub-regionally.
River catchment areas	Global data on rivers and river catchments boundaries have been produced (source ???). Information on lower order catchments varies in detail between regions.	Has potential	The data are not helpful without associated information on individual catchment areas (particularly soil degradation), which would require further research and analysis.

Table 2: Selected candidate criteria for defining priority areas for forest restoration at a regional level

CRITERIA	Critical assumptions	Justification for assumptions
1. Original forest areas which are currently unforested	Current forest areas are not a high priority for restoration; all areas which once supported forest but are now deforested have potential for forest restoration.	Where not already under active management, many forest areas (defined as those with >30% canopy cover and transitional forests with >10% canopy cover) contain sufficient numbers of native species to be able to revert to their natural state. In fact, many degraded forests may be priorities for restoration, but there is insufficient data on forest condition to be able to distinguish between them, natural forests and forests managed for other purposes.
2. Areas containing woodland which are currently unforested	Areas outside existing forests containing patches of woodland in arable land and/or grassland are suitable for forest restoration.	Forest restoration is likely to be most feasible and effective in areas where native woodland species are still found, even if their distribution is highly fragmented. Arable land and grassland with no residual woodlands represent more intensive land use, but could still be restored.
3. Areas of low population density	Areas of high population density (>800 persons per km ² for the Mediterranean region) are unsuitable for forest restoration.	In many countries there is a close correlation between population density and pressure on natural resources (e.g. for non-timber forest products and firewood), reducing the possibilities for successful restoration in areas of high population density. In the developed countries of the Mediterranean region, this correlation is weakened by lack of dependence on local forest resources. However the threshold population density has been raised to limit the extent of excluded areas.
4. Areas in close proximity to forests	Areas immediately adjacent to existing forests and <1 km from the forest boundary are priorities for restoration.	In addition to the importance of proximity to reservoirs of native species, restoration efforts are likely to be focused around existing forests due to site suitability, and planning constraints on other lands.
5. Areas rich in biodiversity	The principal purpose of forest restoration is to conserve biodiversity; areas rich in forest biodiversity are therefore priorities for forest restoration	Restored forests may have other benefits, such as protection of watersheds or even (limited) production of timber. However, other managed forests can offer these benefits more cost-effectively, whilst being less suited to biodiversity conservation, so restoration efforts should be focused on areas of high biodiversity importance.

6. Consultation

WWF experts were asked to comment on the criteria selected for identification of restoration priority areas. A discussion document and map transparencies (which could be used in combination to show how each criterion affected the extent of priority areas) were provided. Feedback from the reviewers has been extremely useful in improving assumptions and selection and analysis of candidate criteria.

A number of points were made by the reviewers, which fell into two categories: those relating to the strategic objectives of forest restoration and those relating to the criteria that could be used for defining priority areas.

The need for identification of clear objectives for forest restoration *before* selection of criteria takes place was noted by most reviewers. Criteria used to identify areas suitable for projects with biodiversity-focused objectives will be very different from those for projects with timber production, protection of water supplies or prevention of desertification as their main objectives.

To complicate matters, all restoration activities will be affected by the policies and incentives of national governments. The objectives of restoration projects throughout the Mediterranean region are therefore likely to vary considerably and it is unrealistic to expect generic criteria to provide accurate mapping at a national level. Nevertheless, most reviewers believed that indicative mapping of priority areas at a regional level was a useful exercise.

A range of additional criteria were thought to merit consideration. These included:

- forest and/or ecosystem type
- legal status of forest (gazetted or non-gazetted)
- land tenure
- historical land use patterns
- soil degradation
- vegetation condition
- river basins
- socio-economic factors (e.g. rural economy)

Whilst these criteria could not be used in this study, their importance is recognised. If the methodology applied here were to be used to define priority areas at a national (rather than regional) scale, it would be extremely useful to include some or all of these criteria. However, in this study we have deliberately excluded data which are specific to the Mediterranean so that comparable analyses can be carried out for other regions.

7. Analysis

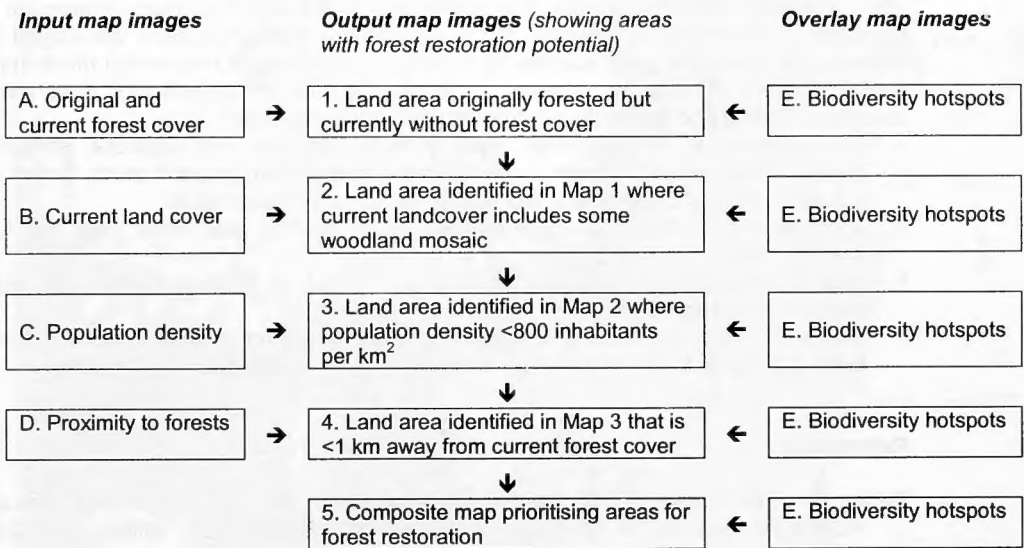
A Geographical Information Systems (GIS) analysis was used to define priority areas according to the criteria listed. Each of the five criteria defined in Table 2 was applied consecutively to reduce the area with potential for restoration. In effect, areas which were not considered to have restoration potential were subtracted from the map at each step (see Table 3).

The order in which the criteria were applied / output images were produced is a (subjective) reflection of their importance in identification of priority areas. The (untested) assumption is that the criteria applied at the beginning of the analysis are less controversial than those applied at the end.

Areas of plant and biodiversity are considered to be relevant to every output image. However, the centres of plant diversity are too broad and the forest hotspots too limited (point locations only) to figure in the analysis. The biodiversity hotspots map has therefore been used as an overlay image in conjunction with each map.

Copies of the maps (numbered / lettered as in Table 3) may be found at the end of the report.

Table 3: Flow chart showing steps in GIS analysis



8. Conclusions

The composite map showing priority areas for forest restoration for the Mediterranean is a first attempt to produce such a regional scale prioritisation. As the selection criteria evolve, the candidate criteria identified in this study will require modification. However, the most urgent next step is the comparison of predicted priority areas on the map with the location projects on the ground; this will determine whether the criteria selected here reflect current policy on project establishment and, if so, where additional projects may be needed.

Selection of criteria for prioritisation depends on the objectives for forest restoration. Crucially, should restoration focus on areas most threatened by human activities (soil erosion, forest exploitation, pollution), or is it more appropriate where there is less pressure on forest ecosystems? There are arguments for both courses of action. The former may yield more conservation benefits, the latter may be more cost-effective. As WWF and other conservation organisations develop regional forest restoration policies, the regional priority-setting tool developed here can be improved.

Selection criteria must then reflect how forest restoration will be implemented. Will restoration efforts build on existing forest, link fragmented woodlands or establish new forests from bare sites? A number of assumptions have been made in this study to limit the scope of the analysis; in fact, it may be necessary to develop alternative priority maps for each possible course of action.

9. Recommendations

To improve the applicability of the regional approach described in this report, we make the following recommendations:

- Identification and mapping of current forest restoration activities, to test the extent to which project location conforms to the rationale used in this study;
- Assessment of objectives of local forest restoration projects, to validate assumptions made and improve the selection criteria (do these reflect objectives set by international bodies working at a regional scale?);
- Reproduction of maps after WWF have agreed regional priorities;
- Repetition of the mapping process for other WWF regions;
- Use of additional criteria excluded in this study through lack of time for analysis.

One issue that has not been addressed in this study is the application of the GIS approach used here at a *sub-national* level. For many parts of the world, spatially-referenced data at this scale are unavailable; however, the Mediterranean region has been the subject of more research and untapped data sources do exist. Using sources of information other than those discussed here, it may be possible to develop a tool for planning of local restoration activities¹. To this end, we make the following recommendations:

- Development of the land-cover layer to show land-use and land-use intensity more clearly; in the case of Europe, agricultural practice is changing and much former military, industrial and agricultural land has a potential for forest restoration.
- Improvement of the accuracy and precision of existing land cover data with updated AVHRR data;
- Use of detailed information on location and status of protected areas for restoration planning and prioritisation;
- Use of spatially-referenced information on forest condition (e.g. as a result of harvesting or fire damage), local conservation priorities and forest management practices.

References

- Tobler, W. Deichmann, U., Gottsegen, J. and Maloy, K. 1995 *The Global Demography Project*. National Center for Geographic Information and Analysis, University of California, Santa Barbara.
- WWF and IUCN 1994 *Centres of Plant Diversity. A guide and strategy for their conservation*. 3 volumes. IUCN Publications Unit, Cambridge, UK.

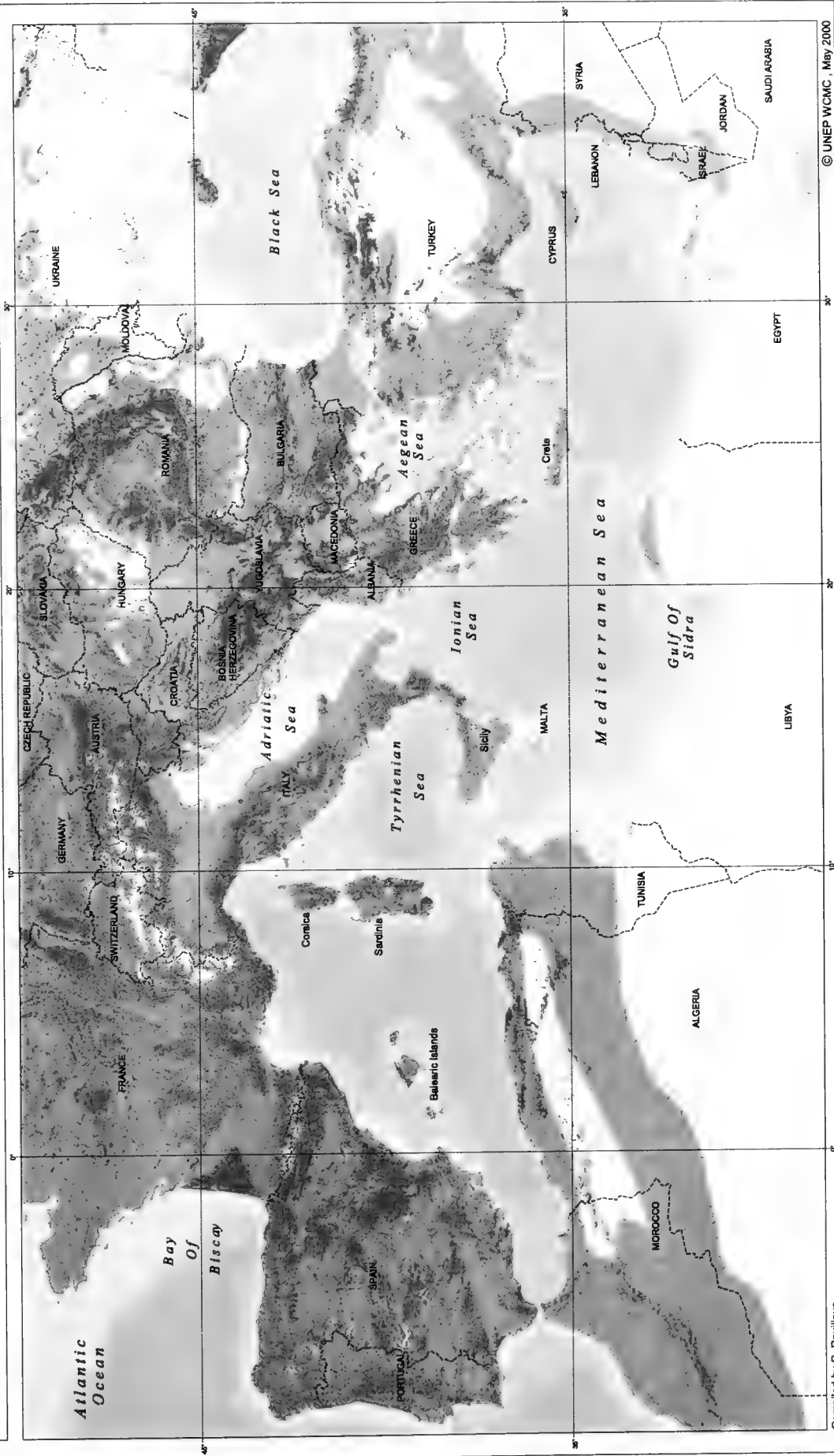
¹ WCMC is currently working with Dr Sandra Luque from the University of Cambridge to develop a landscape level GIS methodology to define forest restoration priority areas for two countries in the Mediterranean region.

A

ORIGINAL AND CURRENT FOREST COVER

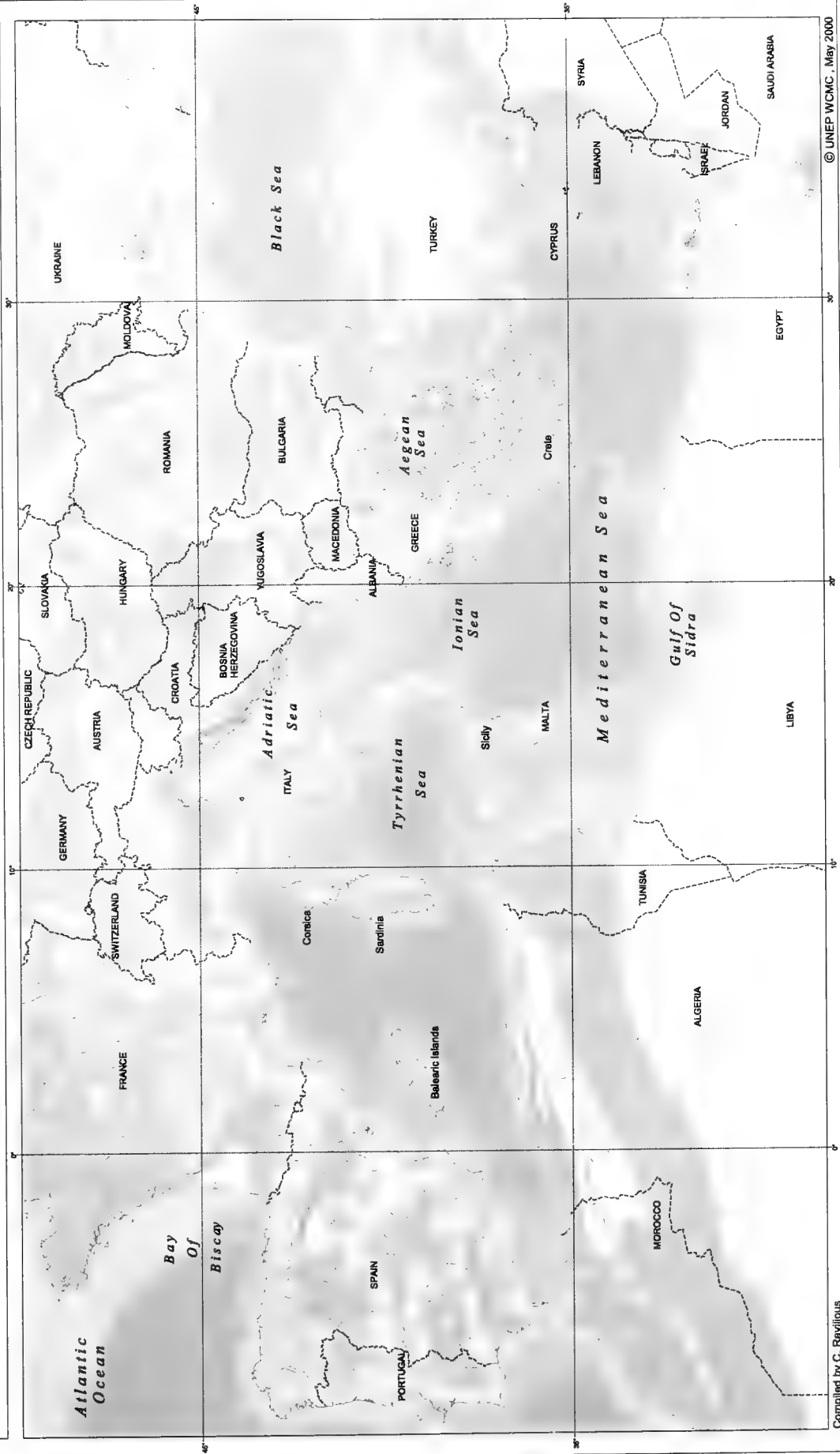


Current forest Original forest



AREAS WITH FOREST RESTORATION POTENTIAL

Land originally forested but currently without forest cover



B

CURRENT LANDCOVER

Grassland and/or arable land
with woodland mosaics

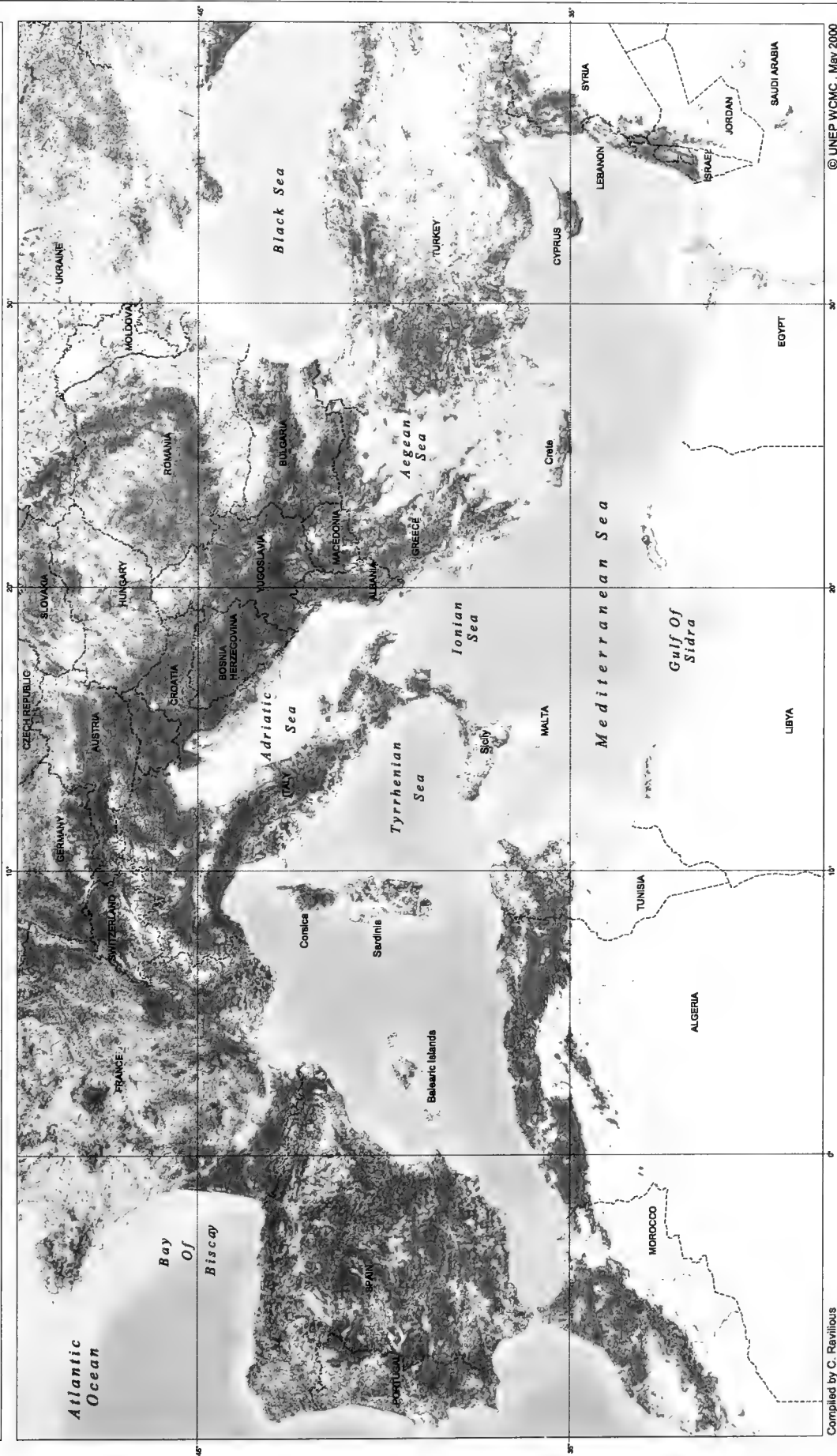
Grassland, arable land and/or shrubland
without woodland mosaics

Current forest cover

Desert, Semi-desert, barren, wetland
and urban land



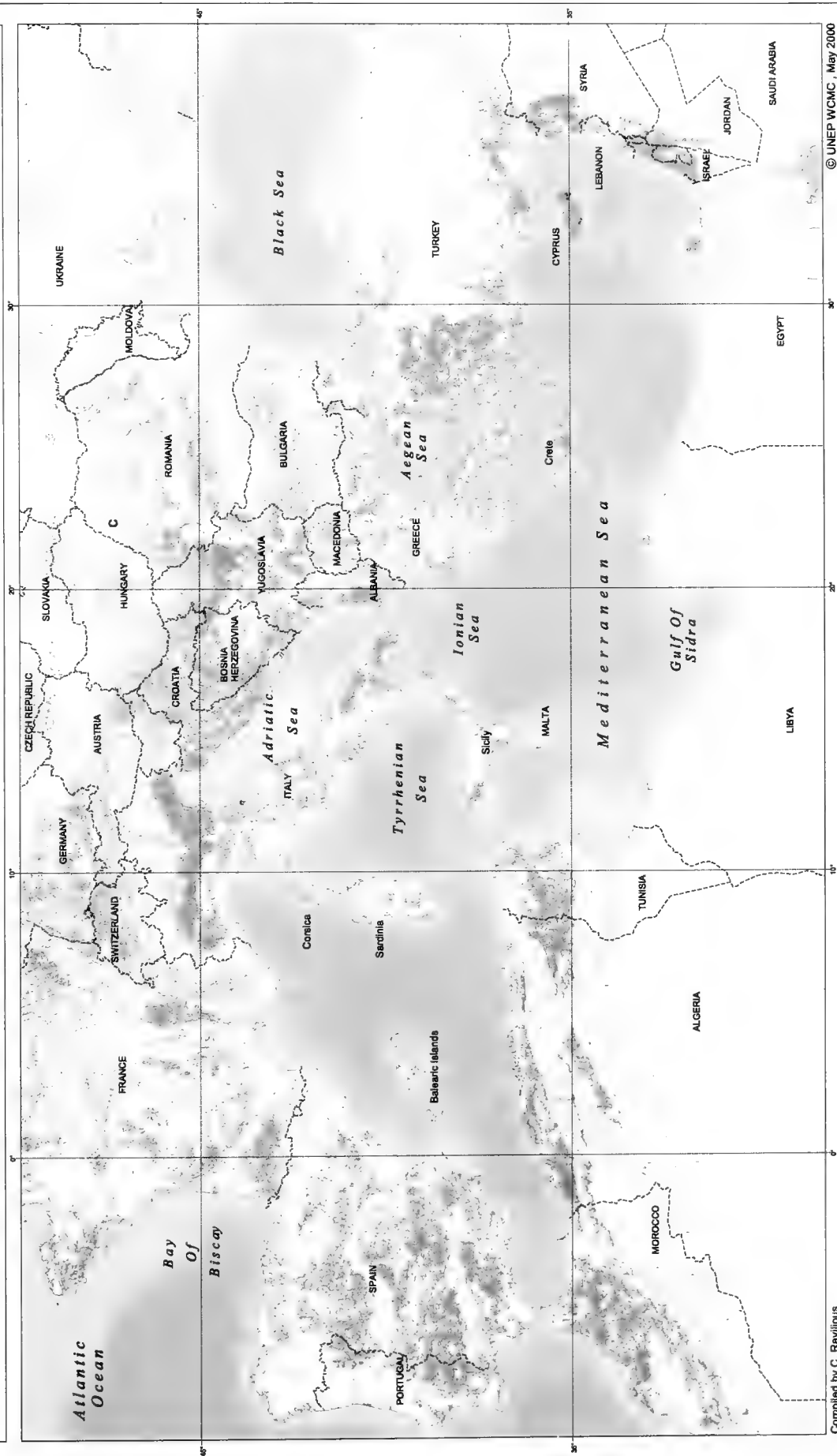
UNEP WCNC





AREAS WITH FOREST RESTORATION POTENTIAL

Land area identified in map 1, where current landcover includes some woodland mosaic





C

POPULATION DENSITY

Inhabitants per sq. km:

0 - 25

26 - 50

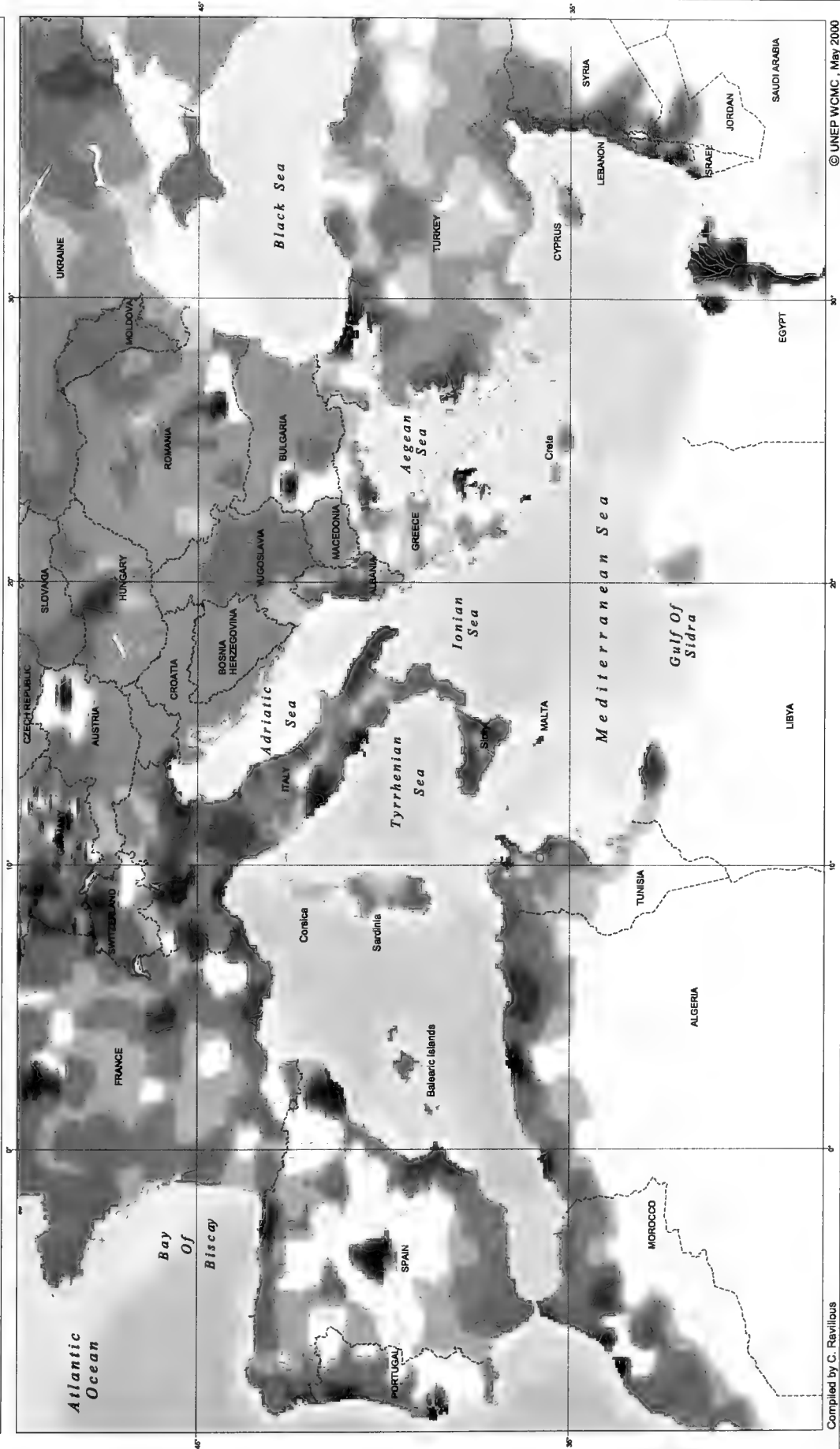
51 - 100

101 - 200

201 - 400

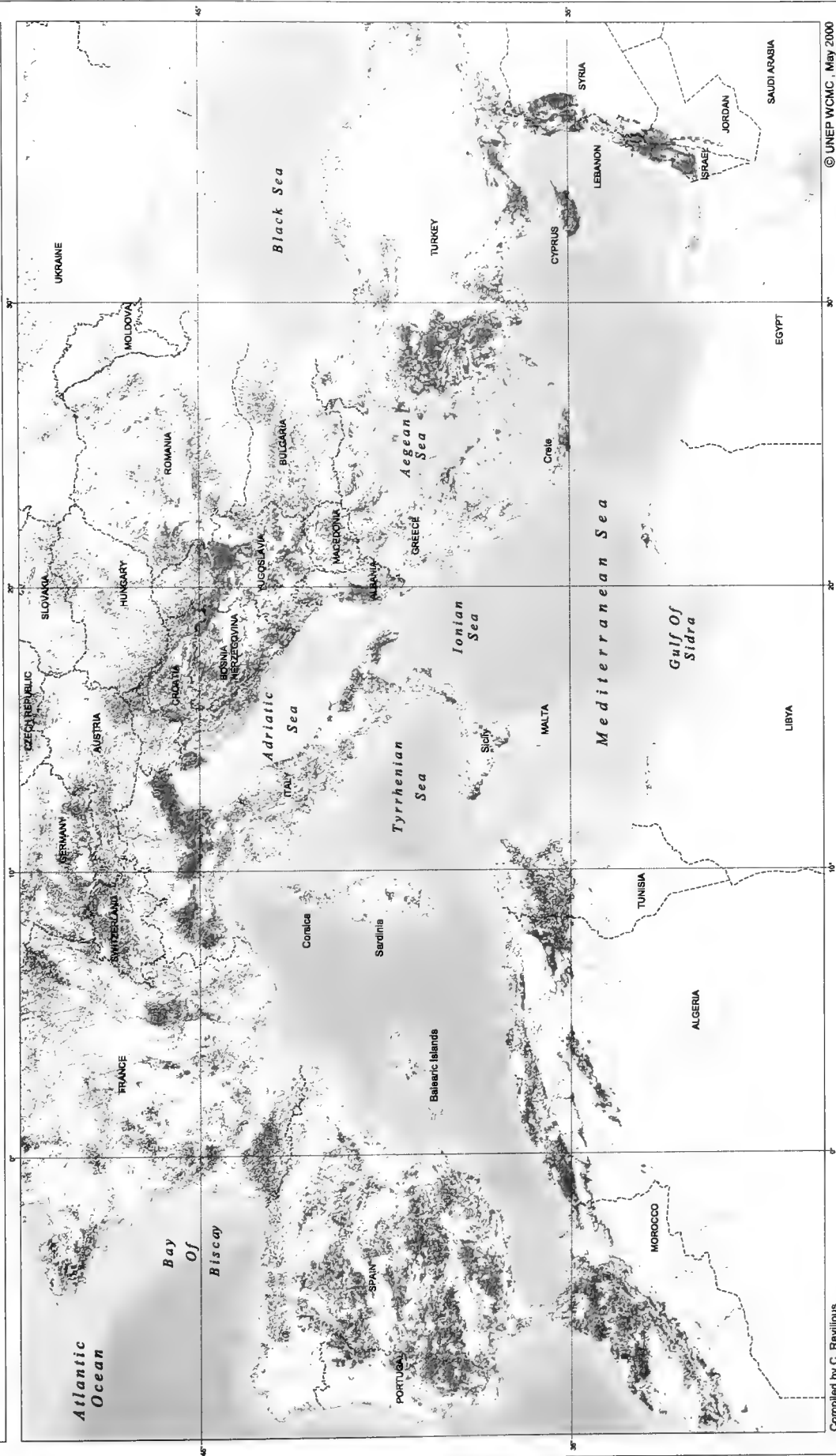
401 - 800

> 800



AREAS WITH FOREST RESTORATION POTENTIAL

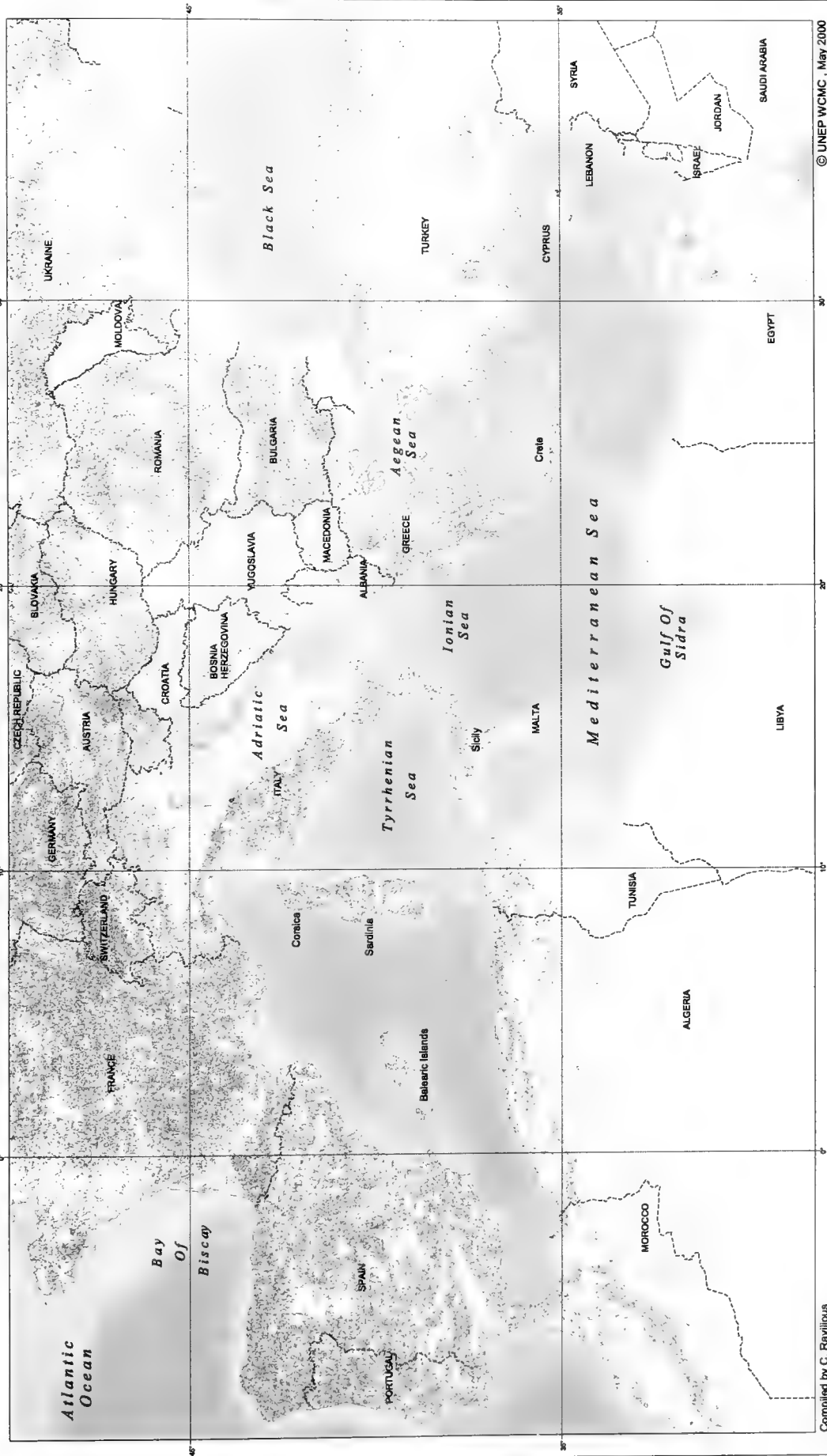
Land area identified in map2, where population density < 800 inhabitants per sq. km



D

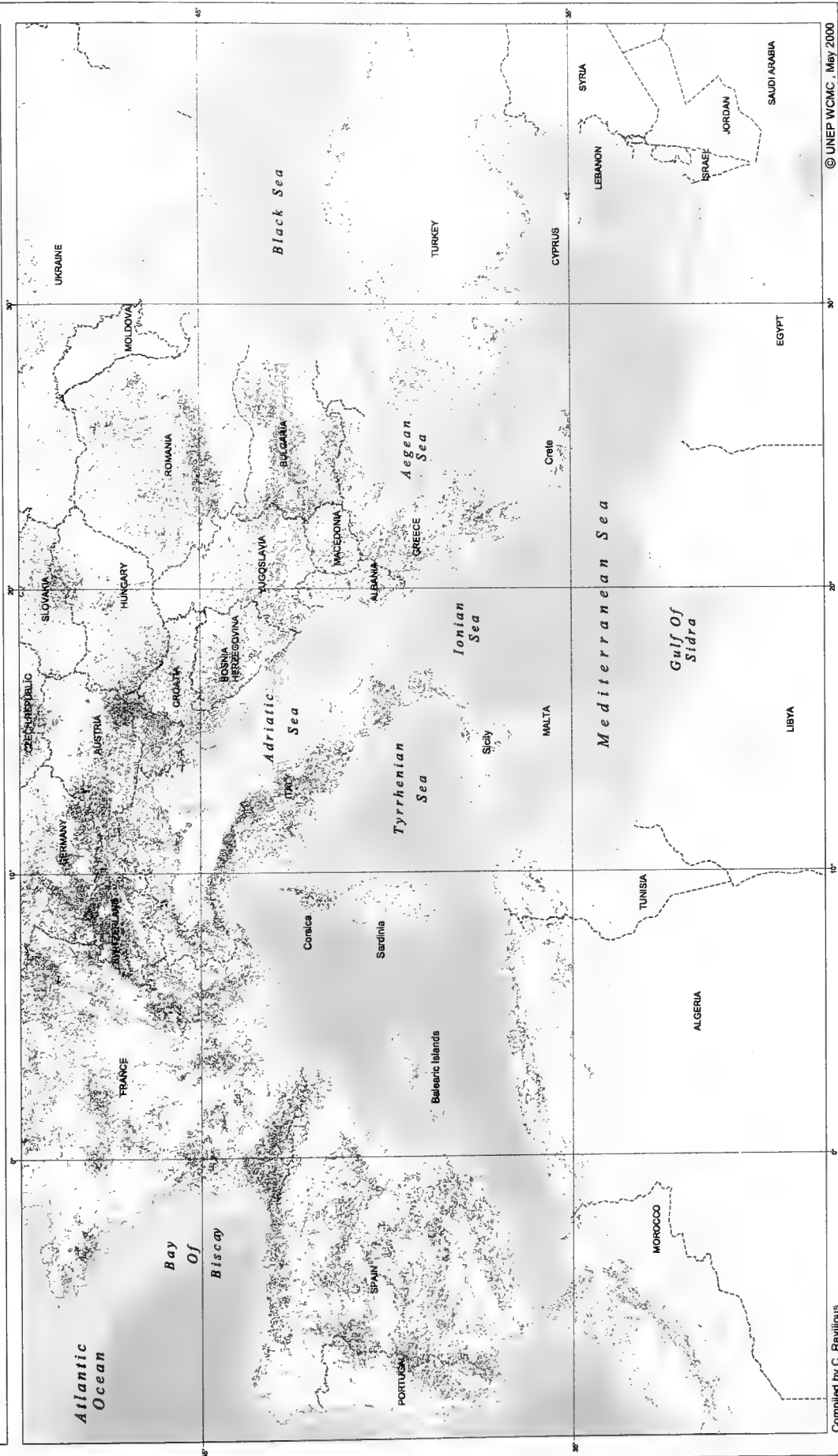
PROXIMITY TO FORESTS

Land within 1km of current forest cover



AREAS WITH FOREST RESTORATION POTENTIAL

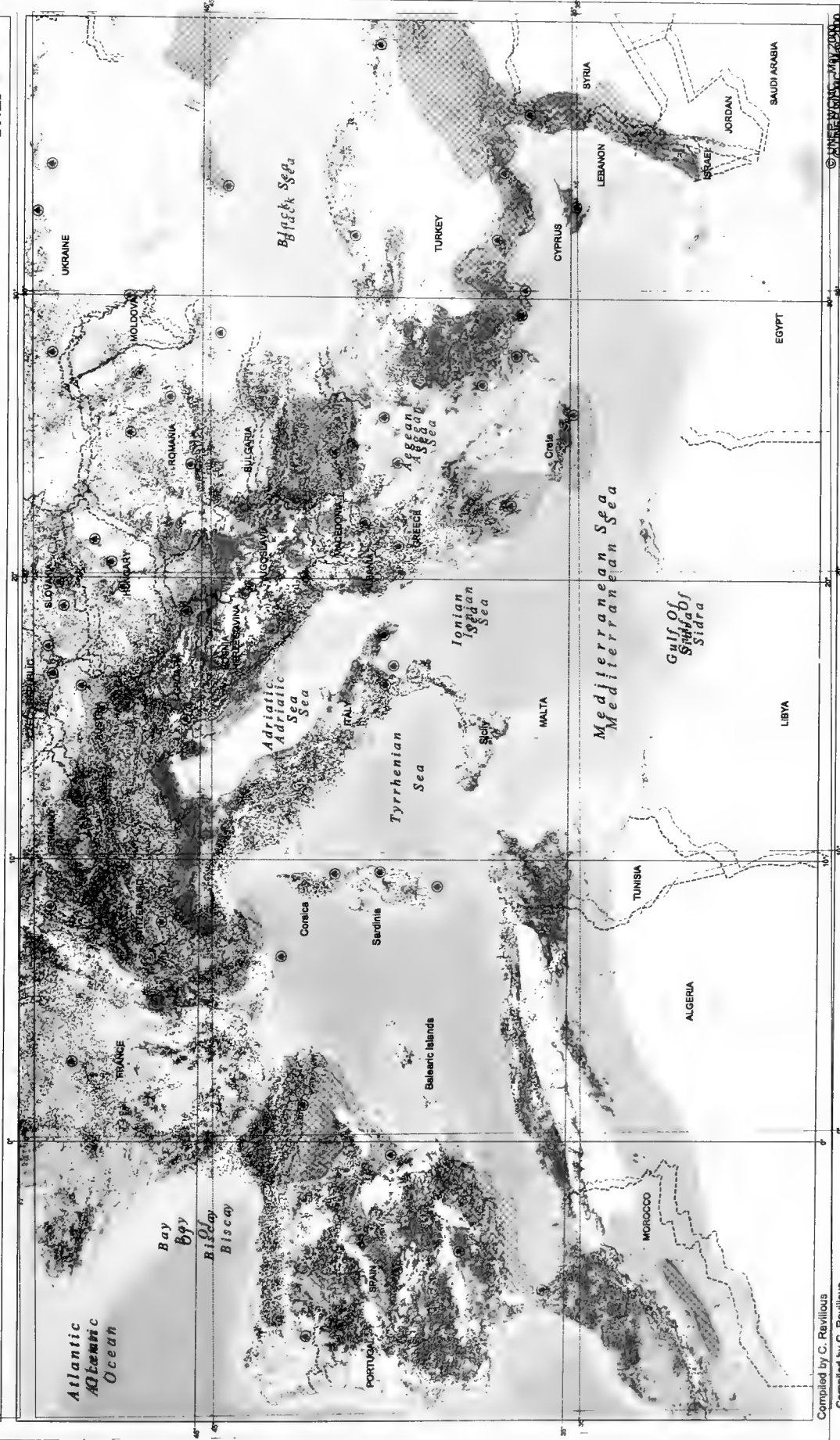
Land are identified in map 3, that is < 1km away from current forest cover

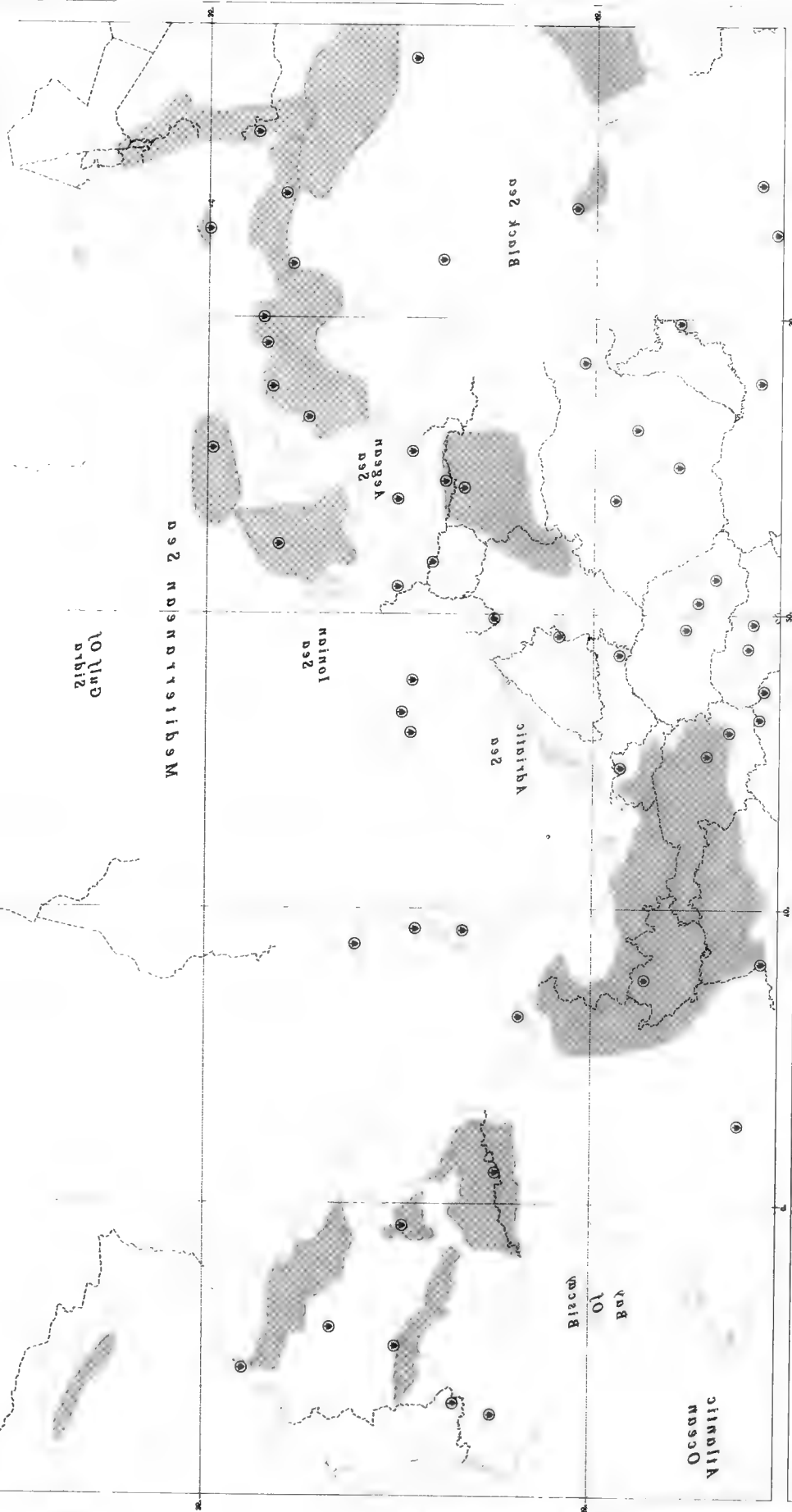


OVERVIEW OF AREAS WITH FOREST RESTORATION POTENTIAL



Highest potential
Centres of plant diversity
Lowest potential
Forest Hotspots (as identified by WWF)





Смещение биологической / Location of biodiversity (as identified by WWF)



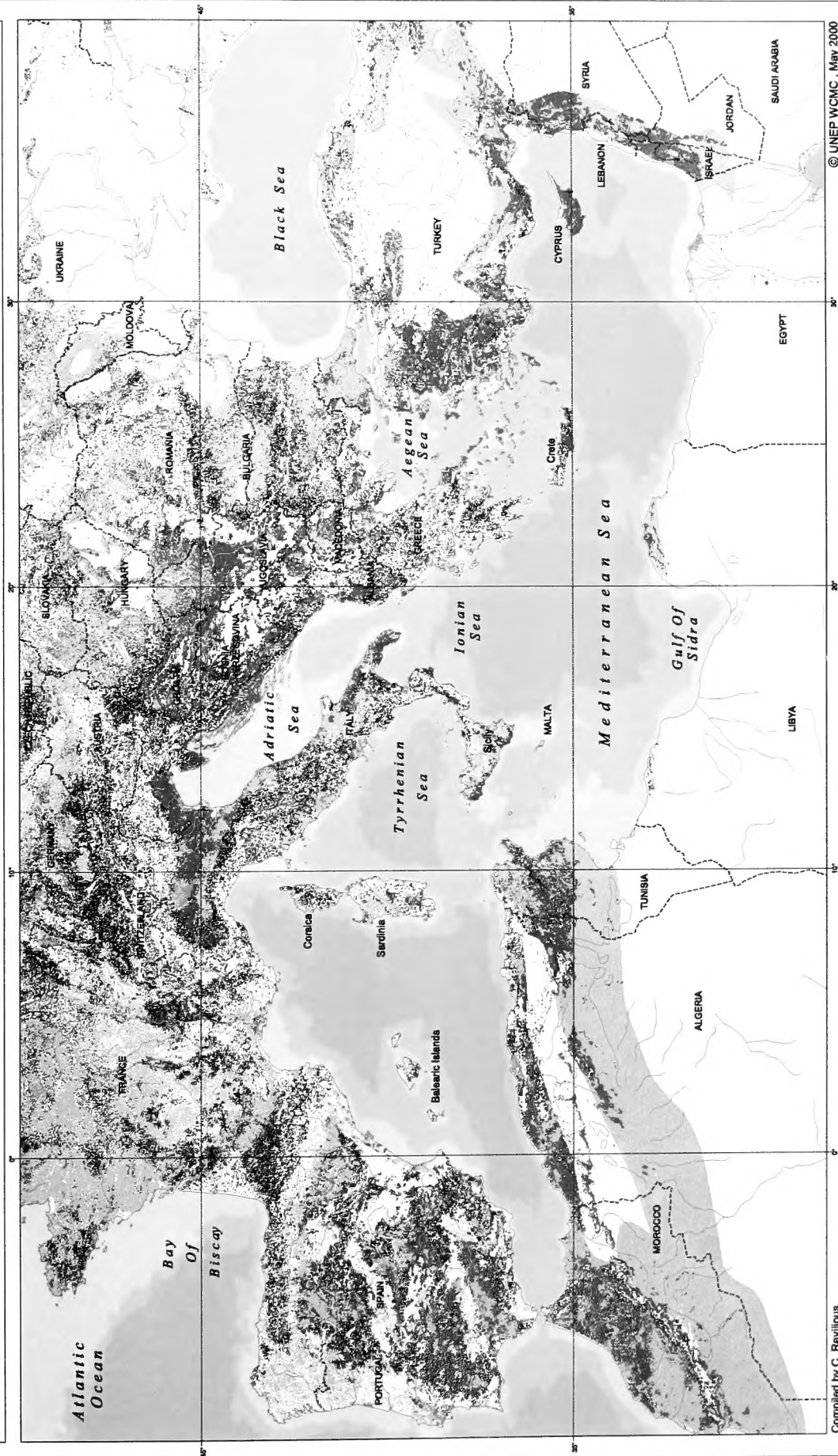
БИОДИВЕРСИТАТНОТЪ ПОСЪТОК

OVERVIEW OF AREAS WITH FOREST RESTORATION POTENTIAL

Highest potential



Lowest potential





WORLD CONSERVATION
MONITORING CENTRE